

PATENT
70071-00004 (POPE#6(CIP)3)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Edward Pope

Serial No.: 10/058,808

Filed: January 28, 2002

Title: PRECERAMIC POLYMERS TO
HAFNIUM CARBIDE AND HAFNIUM NITRIDE
CERAMIC FIBERS AND MATRICES

Art Unit: 1712

Examiner: Margaret G. Moore

REPLY TO EXAMINER'S ANSWER

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
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Sir or Madam:

The appellant filed an Appeal Brief on March 17, 2006 in the above-identified application, to which the Office provided an Examiner's Answer on July 28, 2006 (the "Answer"). No portion of the Appeal Brief has been objected to or denied entry. The appellant respectfully submits this Reply to the Examiner's Answer, pursuant to 37 CFR 41.41.

The Claimed Products Are Formed By Novel Processes And Possess Distinct Properties That are New and Not Obvious Over the Prior Art

It is admitted in the Answer that Hilmas does not disclose all the limitations of the process defined by claim 7. Hilmas is the only reference applied against claim 7, so this admission should not be overlooked: Hilmas fails to disclose or suggest the crosslinking and specific heating steps of claim 7. Answer, §1, ¶¶ 6-8. According to the M.P.E.P. 2113, therefore, the question with respect to patentability of claim 7 is whether the claimed product is the same or similar to the product produced by the process of Hilmas. If not, claim 7 is patentable. As set forth below in more detail, the Answer has failed to establish that the product defined by claim 7 is the same or similar to the product produced by the process of Hilmas, and claim 7 should therefore be allowed.

The situation with respect to claim 8 is a bit more complicated, because both Hilmas and Uemura are separately applied against claim 8. Nonetheless, the central issue is the same: whether the product of claim 8 is the same or similar to the products produced by the processes of either of Hilmas or Uemura. As set forth below in more detail, claim 8 defines a product that is not the same or similar to the products produced by either of Hilmas or Uemura, and claim 8 is therefore allowable. In addition, the Answer attempts but fails to show that Hilmas or Uemura disclose the same process as defined by claim 8. It is demonstrated below that in fact, neither Hilmas nor Uemura disclose the same process as defined by claim 8.

1. THE ANSWER FAILS TO ESTABLISH THAT THE PROCESS OF
CLAIM 7 RESULTS IN A PRODUCT SUBSTANTIALLY IDENTICAL
TO THE PRIOR ART

It is undisputed that the ceramic product produced by the process of Hilmas is not a structural ceramic fiber, as it *must* be carried by a core structural fiber, such as the carbon fiber disclosed in Example 1. Col. 12:1-2; col. 5:14-38. Hilmas discloses a "co-axial filament" that is a "fiber-reinforced matrix composite." Col. 9:10-13. In contrast, as the Answer acknowledges, the process of claim 7 does not require any fiber reinforcement. The specification does not disclose use of additional fiber reinforcement, and one of the benefits of the invention is that no fiber reinforcement is required. This can be extremely beneficial for high-temperature applications, such as rocket nozzles. Hafnium carbide is durable at extreme high temperatures, so eliminating the need for reinforcing materials that are not as durable at extreme high temperatures is plainly beneficial. See, e.g., Application at page 68, line 8 – page 70, line 8.

In the Answer, it is argued that claim 7 does not exclude the possibility of fiber reinforcement. Answer, page 7. This, however, is beside the point. It is undisputed that the fiber produced by Hilmas *must include* a supporting structural carbon fiber, as this is the only structure disclosed, while the fiber of claim 7 *has no need* for a structural supporting fiber, as no supporting fiber is defined and it is plain from the specification that no supporting fiber is needed or desired. Therefore, these are plainly distinct products, and the Examiner has not shown that they are the same or similar. Even if

the fiber-reinforced composite disclosed by Hilmas can be called a ceramic fiber, as the Examiner argues, it makes no difference to the product-by-process analysis. The carbon-reinforced ceramic fiber is still different from a ceramic fiber made by a novel process so as to require no reinforcement. To say that they are the same or almost identical is illogical, and ignores the substantial benefits provided by eliminating the need for a supporting carbon fiber. It is a bit like saying that a rocket that can fly without wings is the same as a plane that requires wings to fly, because wings could theoretically be attached to the rocket. Under this logic, it is doubtful that any product could ever be found distinct from another.

In the Answer, starting at the last full paragraph on page 4 and continuing through the first paragraph ending on page 5, it is argued that the admitted novel steps do not appear to impart distinctive qualities to the final product. However, Applicants bear no burden of demonstrating such facts, and whether or not the distinctiveness of the resulting product is deemed to arise from a particular novel step or steps is immaterial. It is the entire claimed process that is novel, including every claimed step. What is relevant is that the resulting product for the novel process is not the same as what results from prior-art processes, as fully explained above. The distinctiveness of the product arises because the resulting ceramic fiber is derived from a preceramic polymer. The preceramic polymer is, unlike Hilmas, not merely burned away to leave a

pre-existing ceramic material. Instead, the preceramic polymer is transformed via cross-linking and pyrolysis to prepare a ceramic fiber that needs no reinforcement.

The fiber defined by claim 7 is suitably defined by a product-by-process claim, as a product with distinctive self-supporting qualities imparted by the manufacturing process. This is a different result from the carbon-fiber reinforced fiber of Hilmas. The Examiner has set forth no arguments or evidence to support her contention that the claimed hafnium carbide fiber is same or similar to a carbon-reinforced fiber, and on its face this argument is illogical. Because the process of claim 7 is admittedly novel, and the resulting product has not been shown to be the same as the prior art, claim 7 is therefore patentable.

2. THE CERAMIC CONTAINING POLYMER OF HILMAS IS NOT A
"PRECERAMIC POLYMER" AND THUS, HILMAS DOES NOT
DISCLOSE A FIBER DERIVED FROM A PRECERAMIC POLYMER

The Applicant and Examiner are in agreement that Hilmas merely discloses melting a polymer containing a hafnium carbide powder. Therefore, Hilmas fails to disclose a "ceramic fiber comprising hafnium carbide derived from a pre-ceramic polymer," as defined by claim 8.

Hafnium carbide is a ceramic material. Therefore, it cannot also be a pre-ceramic material. The prefix "pre-" must be construed according to its ordinary meaning. Something that is "pre-" proceeds what comes after. For example, an event cannot be considered both "prehistoric" and "historic," as these two words denote

mutually exclusive things. Likewise, a material cannot be both "pre-ceramic" or "ceramic" at the same time. First the material is pre-ceramic, then it becomes ceramic. Hafnium carbide is a ceramic material, therefore it is not a pre-ceramic material. There seems to be no disagreement on this point. Just as plainly, hafnium carbide is not a polymer material, and for this reason also cannot be a preceramic polymer.

The Examiner maintains, however, that the claim term "hafnium containing preceramic polymer" is met by Hilmas, which discloses "a polymer that is not ceramic (i.e. acryloid resin) and contains hafnium carbide." Answer, § 10, ¶ 1. The Examiner helpfully explains that she "does not understand why the acryloid resin in Hilmas et al. is not a pre-ceramic polymer." *Id.* This confusion is perhaps understandable, but results in an erroneous rejection of claim 8. The acryloid resin of Hilmas is definitely not a pre-ceramic polymer.

The acryloid resin is not a pre-ceramic polymer, because it *never becomes a ceramic material*. Instead, the thermoplastic acryloid resin binder is merely used to bind the powdered hafnium ceramic to a supporting carbon fiber prior to pyrolysis. During pyrolysis, the resin material is burned away, leaving the hafnium carbide powder matrix bonded to the underlying carbon fiber. Hilmas, col. 9:6-13; claim 6. As Hilmas explicitly teaches, "[t]he part can then be placed into a furnace and subjected to heat *to burn out any remaining thermoplastic*." Col. 9:6-10 (emphasis added.) The resin of Hilmas is burned away, and is *not* transformed into a ceramic material. Therefore, the resin is *not*

a pre-ceramic material. The distinction from the pre-ceramic polymer defined by claim 8 is clear and fundamental.

In contrast, the present application discloses, and claim 8 defines a ceramic comprising hafnium carbide derived from a pre-ceramic polymer. The specification discloses that the preceramic material is transformed into a ceramic material by pyrolysis. When in pre-ceramic polymer form, the hafnium exists as metal atoms or metallic salt molecules incorporated in the atomic structure of a polymer with carbon, hydrogen and nitrogen atoms. See, e.g., Application at page 70, line 9 – page 71, line 15; Figs. 6-7. Such polymers are plainly not ceramic materials. They are polymers that can be melted at relatively low temperatures and spun to form structural fibers. Page 72, line 12 – page 73, line 14. After crosslinking *and* pyrolysis, the polymer becomes a ceramic material. *Id.*, see also Ex. 27, page 123 et seq. Indeed, the specification consistently uses the term "pre-ceramic polymer" to refer to like polymer materials that are transformed into ceramic materials by crosslinking and pyrolysis.

Those of skill in the art also use the term "pre-ceramic polymer" consistent with the specification and meaning set forth above for claim 8. For example, one engineering teacher described preceramic materials to his students as "similar to conventional thermosetting polymers with the exception of conversion to ceramic with an additional high-temperature processing step." Merve Erdahl, "MS 5199C: Preceramic Polymer Processing Laboratory," Univ. of Minn.,

<http://www.me.umn.edu/education/courses/ms5199/PreceramicLab.html>, accessed Sept. 27, 2006. According to Erdahl, a preceramic polymer must be capable of converting to ceramic upon high temperature processing. This is distinct from the material that Hilmas discloses, which is a ceramic/resin/carbon fiber composite. In Hilmas, the resin is burned away to leave a pre-existing ceramic material supported by a carbon fiber. No conversion of any part of the composite material to ceramic takes place.

Therefore, according to the ordinary meaning of "hafnium containing pre-ceramic polymer," its meaning in light of the specification, and as used in the art, claim 8 requires that the ceramic fiber comprising hafnium carbide be derived from a non-ceramic polymer material; i.e., a material that is capable of being transformed into ceramic upon heat treatment. Hilmas fails to disclose this, and instead discloses burning away a thermoplastic resin to leave a pre-existing ceramic material. Because the resin of Hilmas is burned away, and is not transformed into a ceramic material, it is not a pre-ceramic material. Likewise, the hafnium carbide material of Hilmas is not a pre-ceramic material, because it is already a ceramic when it is co-extruded with a thermoplastic carrier onto a carbon fiber, and is not a polymer material, besides.

Hilmas fails to disclose or suggest a pre-ceramic polymer, and therefore fails to disclose the process by which the fibers of claim 8 are formed. The issue of patentability of claim 8 therefore narrows to the question of whether or not a hafnium

carbide material derived from a preceramic polymer is different from a carbon fiber reinforced hafnium carbide ceramic, as disclosed by Hilmas. The present application teaches how to prepare a ceramic fiber comprising hafnium carbide derived from a preceramic polymer. As the specification teaches, when the ceramic fiber is derived from a preceramic polymer, there is no need for a supporting carbon fiber. For the same reasons as set forth above in § 1 regarding claim 7, it cannot be shown that a carbon-fiber reinforced ceramic as disclosed by Hilmas is the same as a fiber comprising hafnium carbide derived from a preceramic polymer, and therefore Hilmas poses no bar to patentability of claim 8.

It should also be noted that it would be unfair to require Applicant to claim the fiber as consisting of hafnium carbide, because it would be trivial to design around such a claim. The Applicant has advanced the state of the art by showing how to prepare a hafnium carbide ceramic fiber from a preceramic polymer, and is lawfully allowed to claim the new and distinct products that are derived from this novel process.

3. UEMURA DOES NOT DISCLOSE A PRECERAMIC POLYMER, AND THEREFORE FAILS TO DISCLOSE A CERAMIC DERIVED FROM A PRECERAMIC POLYMER

It is undisputed that Uemura, similarly to Hilmas, discloses a composite carbon fiber with a ceramic layer formed by reacting the carbon fiber with a carbide-forming compound. It is admitted that "the fiber in Uemura et al. is a multilayered fiber having an outer ceramic layer." Answer, page 1, lines 7-8. Essentially, this is an end product

similar to that in Hilmas, which also discloses a carbon fiber covered with an outer hafnium carbide layer. The only difference is that in Hilmas, the carbide is added as a powdered ceramic and in Uemura, it is formed by exposing the carbon fiber to a carbide-forming compound. As noted in the Appeal Brief, the carbide layer disclosed by Uemura is very thin, and the product is primarily a carbon fiber. Applicants therefore maintain Uemura does not disclose a ceramic fiber.

But even if Uemura is deemed to disclose a ceramic fiber, it is not derived from a preceramic polymer. In the Appeal Brief, it shown that a carbon fiber is not a preceramic polymer, and this conclusion is not disputed in the Answer. Instead, it is argued that the pitch or polyacrylnitrile (PAN) fibers from which the carbon fibers are formed by pyrolysis are preceramic polymers. Answer, page 8, lines 21-26. As with Hilmas, this interpretation subverts the ordinary meaning of preceramic polymer, its meaning in light of the specification, and its meaning as understood in the art. As shown above, a preceramic polymer is a polymer that converts to a ceramic material upon high temperature processing. Pitch and PAN convert to carbon upon high temperature processing. Carbon is not a ceramic material. Therefore, neither of these carbon precursor materials is a preceramic polymer.

Failing to disclose a preceramic polymer, it follows that Uemura fails to disclose a ceramic fiber of any type derived from a preceramic polymer. Failing to disclose every limitation of claim 8, Uemura poses no bar under § 102.

Nor has there been any showing that the fiber of Uemura is the same as a fiber derived from a preceramic polymer. Uemura discloses a fiber that is principally comprised of carbon, which is plainly different than a fiber comprising hafnium carbide derived from a preceramic polymer, as defined by claim 8. As explained above, the claimed fiber has no need for a carbon fiber or other structural support. Also, Uemura fails to disclose a method for making a ceramic fiber from a preceramic polymer. As a distinct product from a new process, claim 8 is patentable under a product-by-process analysis.

Conclusion

Appellants respectfully request the reversal of the rejection of currently pending Claims 7-8, and allowance of these claims forthwith, for the reasons set forth above and in the Appeal Brief.

Respectfully submitted,



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